



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Jeffrey E. Ungar *et al.*

Application No.: 10/783,269

Filed: February 20, 2004

For: LASER DIODE WITH PHASE
MATCHING GRATING

Examiner: Hung T. Vy

Art Group: 2163

Conf. No.: 7329

SECOND SUPPLEMENTAL APPEAL BRIEF

Mail Stop Appeal Brief - Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

Appellant submits this Supplemental Appeal Brief in triplicate in response to a Notification of Non-Compliant Appeal Brief dated August 24, 2007, for consideration by the Board of Patent Appeals and Interferences. Please charge Deposit Account No. 09-0946 for any required fee. A duplicate of the Fee Transmittal is enclosed for deposit account charging purposes.

I. REAL PARTY IN INTEREST

The real party in interest is the Assignee, Quintessence Photonics Corporation.

II. RELATED APPEALS AND INTERFERENCES

There are no related appeals or interferences known to the Appellant, Appellant's legal representative, or Assignee which will directly affect, or be directly affected by, or have a bearing on the Board's decision in the pending appeal.

III. STATUS OF CLAIMS

Claims 1-14 are pending and remain rejected. The Appellant appeals the rejection of claims 1-14.

IV. STATUS OF AMENDMENTS

An amendment was filed on October 13, 2006 after the Final Office Action dated July 17, 2006.

V. SUMMARY OF CLAIMED SUBJECT MATTER

The following is a summary of the invention recited in the claims including independent claims 1, 6 and 11. For certain applications it is desirable to provide a laser diode(s) that produces light beams with a wavelength between 2-10 μm .¹ Unfortunately conventional laser diodes are fabricated with materials that only generate light with a wavelength between 0.4-1.6

¹ Page 1, lines 16 to page 2, line 9.

μm .² The claimed invention relates to a semiconductor laser diode that internally generates two light beams of different wavelengths and emits a third beam at a third wavelength.³ By way of example, the first and second light beams may have a wavelength of 1.2 μm and 1.65 μm and the third beam has a wavelength of 4.4 μm .⁴ The creation of the third beam involves the following steps:

- 1) Generating first and second light beams that have first and second optical frequencies, respectively;⁵
- 2) Mixing the light beams to generate a polarization wave at a third optical frequency;⁶
- 3) Phase modulating the polarization wave, such as with a phase grating, to couple power from the polarization wave to an electromagnetic wave that propagates at the third optical frequency.⁷

The electromagnetic output beam propagates in a direction perpendicular to the laser axis of the laser diode.⁸ The output beam is perpendicular to the first and second light beams.

The modulating step is an important one because the polarization wave has a spatial propagation constant that differs from a freely propagating electromagnetic wave of the same

² Page 1, lines 11-13; page 2, lines 18-9.

³ Page 5, lines 2-14.

⁴ Page 7, lines 6-8; page 8, lines 4-7.

⁵ Page 6, line 1 to page 7, line 2.

⁶ Page 7, lines 3-6; page 8, line 7 to page 10, line 4.

⁷ Page 7, lines 16 to page 8, line 6; page 10, lines 4-16.

⁸ Page 5, lines 11-15.

frequency.⁹ Without phase modulation, the power from the polarization wave will not directly couple into an output beam. The semiconductor includes a phase grating that phase modulates the polarization wave to compensate for the difference in the spatial propagation constants so that the electromagnetic wave is excited.¹⁰ By way of example, the phase grating may have a form to phase modulate the polarization wave by a multiplication factor $\cos(k_1 - k_2)z$.¹¹

Listed below are the independent claims with reference to the specification by page and lines numbers, and to the drawings by reference numbers (in parenthesis), if applicable.

1. A semiconductor laser (10) , comprising: (page 5, lines 16-18)
a first optical gain element (16) that generates a first light beam having a first optical frequency; (page 5, lines 18-20; page 6, line 1 to page 7, line 2)
a second optical gain element (18) that generates a second light beam having a second optical frequency; (page 5, lines 18-20; page 6, line 1 to page 7, lines 2)
an optical frequency mixer (12) that is coupled to said first and second gain elements and mixes said first and second light beams to generate a polarization wave at a third optical frequency; and (page 7, lines 3-10; page 8, lines 7 to page 10, line 4)
a near-field phase grating (22) that phase modulates the polarization wave to couple a power from the polarization wave to an electromagnetic wave that propagates at the third optical frequency. (page 7, line 16 to page 8, line 6; page 10, lines 4-16)

⁹ Page 7, lines 16-20.

¹⁰ Page 10, lines 1-15.

¹¹ Page 10, lines 4-7.

6. A semiconductor laser (10), comprising: (page 5, lines 16-18)
a first optical gain element (16) that generates a first light beam having a first frequency;
(page 5, lines 18-20; page 6, line 1 to page 7, line 2)
a second optical gain element (18) that generates a second light beam having a second
frequency; (page 5, lines 18-20; page 6, line 1 to page 7, line 2)
mixing means (12) for mixing the first and second light beams to create a polarization
wave at a third optical frequency, and; (page 7, lines 3-10; page 8, lines 7 to page 10, line 4)
phase modulation means (22) for phase modulating the polarization wave for coupling a
power of the polarization wave to an electromagnetic wave that propagates at the third optical
frequency. (page 7, line 16 to page 8, line 6; page 10, lines 4-16)

11. A method for operating a semiconductor laser (10), comprising:
generating a first light beam having a first optical frequency; (page 6, line 1 to page 7,
line 2)
generating a second light beam having a second optical frequency; (page 6, line 1 to page
7, line 2)
mixing the first and second light beams to create a polarization wave at a third optical
frequency, and, (page 7, lines 3-10; page 8, lines 7 to page 10, line 4)
phase modulating the polarization wave to couple a power of the polarization wave to an
electromagnetic wave that propagates at the third optical frequency. (page 7, line 16 to page 8,
line 6; page 10, lines 4-16)

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

The issues presented by this appeal are:

- Whether claims 1-14 are anticipated under 35 U.S.C. § 102(e) by U.S. Patent No. 6,853,666 to Evans et al. (“Evans”).
- Whether claims 1, 3, 6, 8, 11 and 13 are anticipated under 35 U.S.C. § 102(b) by U.S. Patent No. 5,757,832 to Uchida (“Uchida”).

VII. ARGUMENT

A. Claims 1-14 are Not Anticipated by Evans

The Examiner contends that Evans discloses a frequency mixer that generates a polarization wave at a third optical frequency, and a phase grating that phase modulates a polarization wave to couple power from the polarization wave to an electromagnetic wave propagating at the third optical frequency. This is not true. Although Evans discloses a phase grating, there is no disclosure or suggestion that the grating has a period that couples power from a polarization wave into an electromagnetic wave. Not any grating will couple power from a polarization wave with a third optical frequency to an electromagnetic wave with the same frequency. By of example, the specification of the above entitle application discloses a grating constructed to modulate the polarization wave with a multiplication factor $\cos(k_1 - k_2)z$. The mere existence of a phase grating in Evans does not satisfy the modulation structure and step recited in the claims. Evans does not disclose a structure or step for coupling power from a polarization wave of a third frequency to an electromagnetic wave of the same frequency. To support his position, the Examiner merely points to Figures 1, 2 and 14 of Evans.

Figures 1a and 1b of Evans discloses a device with two integrated lasers. This embodiment does not create two light beams with different optical frequencies. The embodiment shown in Figures 2a and 2b can be constructed to generate and emit light beams with different

optical frequencies. Figure 2b of Evans reproduced below discloses perpendicular lasers y and z (6y,7y and 6z,7z) and a single grating 8y,8z. The grating 8y,8z directs the light from the y and z lasers.

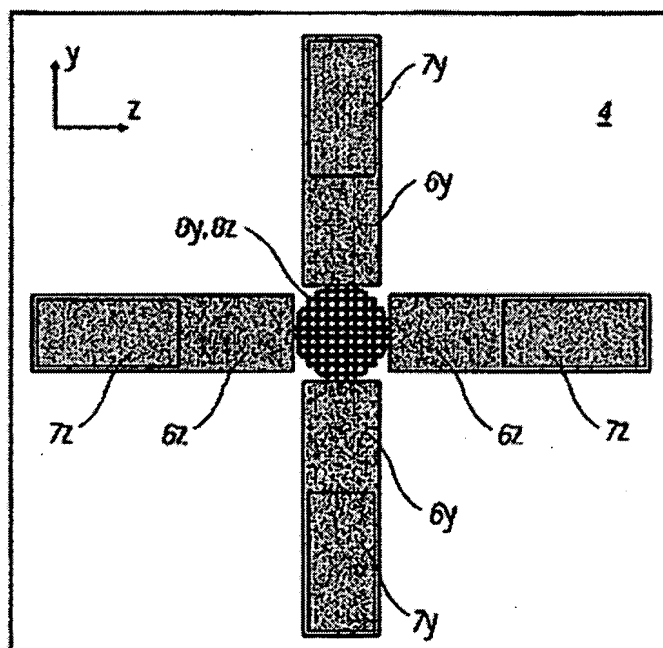


Fig. 2b

As shown in Figure 2c of Evans, reproduced below, the grating has perpendicular lines 8y and 8z. The spacing of the 8y lines can be constructed to outcouple the light from the y lasers. the spacing of the 8z lines can be constructed to direct light out from the z lasers.

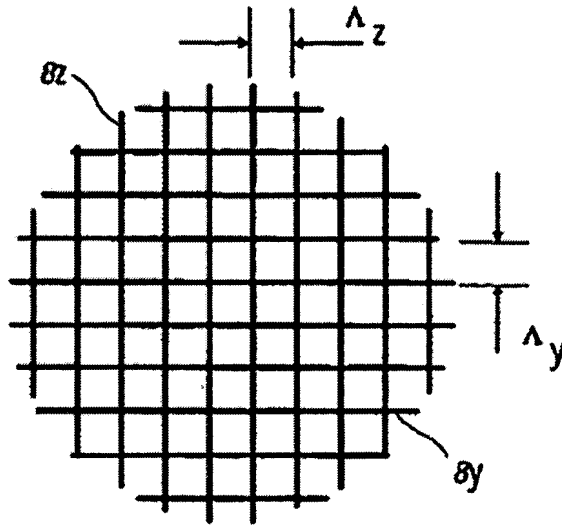


Fig. 2c

The following passage of Evans describes what occurs when the y and z lasers generate light of different wavelengths:

"The reflector grating periods for the pair of lasers can be the same, which provides additional power and polarization. Alternatively, the grating periods can be different, resulting in two different wavelengths of light being out-coupled. This latter configuration can couple light of different wavelengths out at the same angle for coupling of the different wavelengths into the same fiber, saving the cost of implementing a combiner for this function. For example, if the two lasers have different feedback grating periods, they will each generate a different wavelength of light. But both lasers can emit their light normal to the surface of their respective outcoupling grating by choosing each individual outcoupling grating to couple the necessary wavelength of light out normal to the surface." Col. 8:51-64.

This embodiment of the device creates beams of different wavelengths that are then coupled into a single fiber. The Examiner states that there must be coupling of power because there is only one grating. Actually there are two gratings δy and δz that intersect over the same area. The spacing of the δy and δz gratings can be varied to provide the desired output for each

laser ("For example, the two crossed OC gratings of FIG. 2b can be chosen to outcouple different wavelengths of light, allowing the two lasers of the crossed laser configuration to have different wavelengths, one in the z-direction, another in the y-direction." Col. 8:7-11). Evans does not describe or suggest to mix the beams to create a polarization wave having a third optical frequency. Likewise, the grating in Evans does not phase modulate a polarization wave of a third optical frequency to couple power from the polarization wave to an electromagnetic wave of the same frequency.

The applicant is not sure why the Examiner points to Figure 14 of Evans to support his position. The accompanying text merely talks about thinning the quantum well beneath the reflector gratings 7 to reduce losses (see Col. 11:57-12:23). There is no discussion about mixing beams and modulating a polarization wave.

Evans does not disclose mixing two light beams of different optical frequencies to generate a polarization wave at a third optical frequency, and phase modulating the polarization wave to couple power from the polarization wave to an electromagnetic wave that propagates at the third optical frequency as recited in the claims. For these reasons, Evans does not anticipate claims 1-14.

B. Claims 1, 3, 6, 8, 11 and 13 are Not Anticipated by Uchida

Like Evans, Uchida also does not disclose a semiconductor laser diode that mixes light beams having different frequencies to create a polarization wave at a third optical frequency, and phase modulating the polarization wave to couple power from the polarization wave to an electromagnetic wave at the third optical frequency.

Uchida discloses a laser diode that can switch between two different polarization modes ("According to one aspect of the present invention, there is provided an optical semiconductor device, such as an oscillation polarization selective semiconductor laser for switching an oscillation polarization mode between two different polarization modes...". Col. 2:58-62). One

of the objects of Uchida is to make the threshold gains of each mode equal ("In addition, the device has different polarization modes (for example, TE mode and TM mode), and their threshold gains should be equal to each other." Col. 5:48-50. This is also referred to as relation (3)). Uchida discloses a structure that includes two gain regions and a lossy region, wherein the currents and voltage are adjusted so that the threshold gains are equal (see Col. 8:27-31). The currents can be adjusted by modulating a bias current injected into one of the gain regions (see Col. 8:38-41).

Uchida does not disclose mixing light beams of different wavelengths. The Uchida devices switches between two different polarization modes. This is not mixing light beams. Uchida does not disclose phase modulating a polarization wave to couple power from the wave to an electromagnetic wave of the same frequency. The grating of Uchida is used as a feedback element to generate laser light selected to correspond with the peak gain for one of the polarization modes ("The pitch of the grating 510 is set such that its Bragg wavelength for the TM mode is positioned at a gain peak wavelength." Col. 14:61-3). The grating disclosed in Uchida is not phase modulating a polarization wave to couple power into an electromagnetic wave. The modulation described in Uchida is of a current being injected into the gain regions. Uchida does not disclose phase modulating a polarization wave generated from the mixing of two different light beams.

Uchida clearly lacks any disclosure of beam mixing and the modulation of a polarization wave to couple power from the wave to an electromagnetic wave of the same frequency. For these reasons Uchida does not anticipate claims 1, 3, 6, 8, 11 and 13.

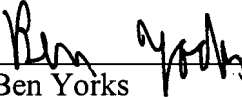
C. Conclusion

Both Evans and Uchida do not disclose the limitations of mixing first and second light beams to create a polarization wave at a third optical frequency, and phase modulating the polarization wave to couple power from the polarization wave to an electromagnetic wave that propagates at the third optical frequency. Lacking these claim limitations neither reference can anticipate the claims of the above entitled application. The Examiner appears to be taking the position that because these references disclose some of the limitations of the claims the components must be cooperating in the same manner as the structures and methods recited in the claims. The generation of two light beams or the existence of two gain regions does not mean the beams are mixed. Likewise, the disclosure of a grating does not mean that a polarization wave is phase modulated to couple power into an electromagnetic wave of the same frequency. Every limitation of the claims must be found in each reference. As noted above both Evans and Uchida are clearly missing limitations of the claims.

Respectfully submitted,

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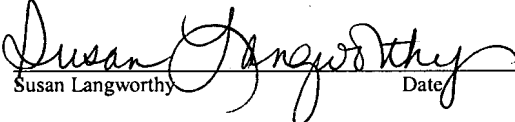
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Susan Langworthy
Date Oct 4, 2007

VIII. CLAIMS APPENDIX

The claims on appeal are:

1. (Previously Presented) A semiconductor laser, comprising:
a first optical gain element that generates a first light beam having a first optical frequency;
a second optical gain element that generates a second light beam having a second optical frequency;
an optical frequency mixer that is coupled to said first and second gain elements and mixes said first and second light beams to generate a polarization wave at a third optical frequency; and
a near-field phase grating that phase modulates the polarization wave to couple a power from the polarization wave to an electromagnetic wave that propagates at the third optical frequency.
2. (Original) The laser of claim 1, wherein the third optical frequency is in the mid-infrared, long-infrared or Terahertz regions.
3. (Original). The laser of claim 1, wherein said optical frequency mixer includes a waveguide optically coupled to said first and second gain elements.
4. (Original) The laser of claim 1, wherein the electromagnetic wave propagates in a direction essentially perpendicular to a propagation direction of the first and second light beams.

5. (Original) The laser of claim 1, wherein the semiconductor laser is fabricated with group III-V material.

6. (Previously Presented) A semiconductor laser, comprising:
a first optical gain element that generates a first light beam having a first frequency;
a second optical gain element that generates a second light beam having a second frequency;
mixing means for mixing the first and second light beams to create a polarization wave at a third optical frequency, and;
phase modulation means for phase modulating the polarization wave for coupling a power of the polarization wave to an electromagnetic wave that propagates at the third optical frequency.

7. (Original) The laser of claim 6, wherein the third optical frequency is in mid-infrared, long-infrared or Terahertz regions.

8. (Original) The laser of claim 6, wherein said mixing means includes a waveguide for mixing said first and second light beams.

9. (Original) The laser of claim 6, wherein the electromagnetic wave propagates in a direction essentially perpendicular to a propagation direction of the first and second light beams.

10. (Original) The laser of claim 6, wherein the semiconductor laser is fabricated with group III-V material.

11. (Previously Presented) A method for operating a semiconductor laser, comprising:

generating a first light beam having a first optical frequency;

generating a second light beam having a second optical frequency;

mixing the first and second light beams to create a polarization wave at a third optical frequency, and,

phase modulating the polarization wave to couple a power of the polarization wave to an electromagnetic wave that propagates at the third optical frequency.

12. (Original) The method of claim 11, wherein the third optical frequency is in the mid-infrared, long-infrared or Terahertz regions.

13. (Original) The method of claim 11, wherein the first and second light beams are mixed in a waveguide.

14. (Original) The method of claim 11, wherein the electromagnetic wave propagates in a direction essentially perpendicular to a propagation direction of the first and second light beams.

IX. EVIDENCE APPENDIX

None

X. RELATED PROCEEDINGS APPENDIX

None